

On Some of the Relations
of the
Business of the Dairy Farmer
to
Public Health.

BY

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*An Address delivered before the Glasgow and West of Scotland
Agricultural Discussion Society, 15th January, 1890.*

GLASGOW:

PRINTED BY ALEX. MACDOUGALL, 81 BUCHANAN STREET.

1890.

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ON SOME OF THE RELATIONS OF THE BUSINESS OF THE DAIRY FARMER TO PUBLIC HEALTH.



It is not the benign and wholesome influence of normal milk on public health which I propose to discuss, but the mischievous and unwholesome effects of abnormal milk. Milk may be made a medium for the propagation or conveyance of communicable disease. It is often popularly said that milk has been the cause of some specific disease, such as enteric fever or scarlet fever, but in reality it is only the germs or microscopic seeds of disease which are conveyed by the milk as a medium. It is not, therefore, the disease which has been conveyed by the milk, but the germs or seeds of the disease, and these find a nutritious soil in the body, and by their growth and multiplication, and the various products of their life, set up the disease. Milk is only one of many media by which these germs reach their proper soil. Thus, for example, the air may be the medium in which the dust of a scarlet fever patient's skin is borne from one person to another, precisely as it floats the thistle-down from field to field. So with water. Just as it is the medium by which the milt is conveyed to and fertilizes the roe of most fishes, so it carries the enteric germ from the body of an infected person to the stomach of a healthy person. Soiled clothes, dirty hands, dirty dishes may all act as media, as the bee is the medium by which the fertilizing pollen is conveyed from flower to flower. But while milk is only one of many media by which the germs of communicable disease may be conveyed, it is the most dangerous of all, inasmuch as it is a secretion charged with nutrient material, which not only receives these germs, but sustains, nourishes, and propagates them. Not only in respect of containing appropriate food, but in respect of the initial temperature at which it leaves the body of the cow, milk, in the language of the experimental bacteriologist, is one of the best "culture materials" for micro-organisms.

It is by the careful preparation of "culture material," which has been sterilized or freed from pre-existing germ life, that an artificial soil is obtained in which microscopic organisms can be experimentally sown or planted. Their growth can then be watched, and particular germs can be selected for trial on animals; and from the results we can determine whether they are the true causes of special diseases. Some culture fluids are broths made from meat; others are solutions of organic substances, such as peptone, cane-sugar, &c., in distilled water; while blood-serum, urine, and milk are the chief natural fluids which after sterilization are used for this purpose. This precaution is specially necessary in the case of milk, which, we are told, as obtained from the dairy, always swarms with bacterial life.

Lister, who founded the life-saving system of antiseptic surgery on such experiments, makes the following statement in a most interesting and valuable paper "On Lactic Fermentation,"* to which I shall have again to refer:—"Milk is a material which serves as a pabulum for almost all organisms. I once met with a bacterium which would not live in milk; for extremely numerous as the varieties of bacteria appear to be, almost all of them seem to thrive in that liquid, whereas it is a common thing to find bacteria which, if put alive into Pasteur's solution will not grow in it at all" (p. 435). Pasteur's solution is a well known artificial fluid "culture material;" and Lister found normal milk to be a more generous soil for the growth of bacteria. Other authorities tell us that the "pathogenic" or disease-producing class of those organisms flourish in milk and other natural animal fluids, while they perish in artificial fluids. You will, no doubt, recognize the extreme practical importance of these observations in an inquiry into the action of milk as a medium of specific disease. Air will only convey the germs imparted to it, and will, in fact, being a dry medium, and in virtue of the oxygen which is its chief constituent, ultimately destroy them if they are not previously wafted to some congenial soil. Even water, unless highly polluted with organic matter, will not long support, and will not propagate the seeds of disease. Most other media only give what they receive; but milk nourishes and multiplies, to an extent proportioned to the time which elapses between its extraction from the cow and its use as food, whatever disease germs it may have been contaminated with.

You may have been startled, possibly alarmed, by a statement which I have just made—that, as obtained from the dairy, milk swarms with bacterial life. To mitigate your alarm, I may remind you that, although you seldom hear of bacteria except as the cause or associate of disease and mischief, microscopic organisms resemble the larger growths of vegetation in this as in other respects: that although some are hurtful and poisonous,

* *Transactions of the Pathological Society of London*, 1878, p. 425.

others, and those the majority, are beneficent, or at least harmless. There are bacteria which can live and grow on the tissues of living animals: those are they which cause disease, which we have, therefore, good reason to fear, and which are only accidentally and rarely present in milk. There are bacteria which only act on dead organic matter, which are the cause of putrefaction or decay, and so far are useful in their right place. Others are the active agents in fermentive processes, such as "souring;" or cause that rarer form of physical change—viscid, stringy milk. Many more are simply regarded as interesting little organisms, which, in growing, produce beautiful pigments—red, yellow, blue, orange, &c.—and of which the most that can be said is that their part in the economy of the world is not precisely known, although they in all likelihood lead innocent, if not positively useful, lives. All these latter bacteria agree in this: that they cannot live in the tissues or vital fluids of a healthy living animal.

Now, let us exclude from our consideration at present those rare pathogenic or disease-producing germs, and consider those "swarms of bacterial life" which are always present in dairy milk. Where do they come from? If they cannot live in the body of a healthy animal, it is certain they will not be found in the milk as it is drawn from a healthy animal. That is quite a safe course of argument; but let us see what experiment has got to say. If you enjoy close, clear reasoning from simple experiment and observation, you will find pleasure as well as information in Lister's paper "On Lactic Fermentation," already quoted. In plain language, the subject is the process of souring in milk; what is its cause? In the first place, he proved that, if you took ordinary dairy milk, full of organisms, and killed all those organisms by exposure for an hour to a temperature of about 210° F., just short of boiling, in a flask in which it would be preserved from the access of germs from the air subsequently, you had milk which did not sour or putrify for weeks. Mr. Lister read his paper before the Pathological Society of London, on 18th December, 1877, and he said:—"Here is a flask of boiled milk (or rather of milk that has been exposed to a temperature of 210°) prepared on the 7th of August, and remaining, we may safely say, as pure as it was then. You observe it is still perfectly liquid and unaltered in appearance." From 7th August to 18th December this milk was free of all germs, and free of change. Then step by step he demonstrates that of all these germs it is one—the *bacterium lactis*—which is the cause of "lactic fermentation" or souring. He says—"It may seem strange that the ferment that leads to the souring of milk should be rare, but such is the fact: *in dairies it appears to be universal*, but in the world at large it is scarce." He had a cow milked "in a little orchard belonging to a dairy farm, and within two yards of the dairy itself," the teat being washed

simply by milking for a time before taking the sample. He then, with precautions, divided the milk in a room in the farmhouse into twenty-four sterilised glasses, which he covered securely, and watched. Every one showed signs of alteration from the development of organisms, chiefly those which produce various colouring matters, but *not one turned sour*. Even in the cow-house itself, "the teat of the cow and the milk-maid's hands having been washed with strong watery solution of carbolic acid," milk was drawn and distributed into twelve glasses as before; and while all underwent changes, and developed organisms, none soured or showed the *bacterium lactis*. Finally, with still more rigid precautions to prevent organisms reaching the milk from the air or the surface of the teat, he obtained twelve samples, of which two remained perfectly unchanged in aspect six weeks after the performance of the experiment; and, on examining the milk from one of these, he found it fluid, perfectly natural in reaction and in taste, and free from any organisms that could be discovered by the microscope. "Thus," he proceeds, "was at length attained the object of these experiments with the little glasses—viz., the proof that *unboiled milk, as coming from a healthy cow . . . really contains no material capable of giving rise to any fermentative change, or to the development of any kind of organism which we have the means of discovering.*"

Thus, while we began by informing you that, "as milk is delivered for use, it swarms with the seeds of bacterial life,"* we end by the hopeful assurance that these do not come from the healthy cow, and are therefore not necessary constituents of healthy milk. This is true not only of the class of bacteria which are incapable of living in the healthy body, but *a fortiori* of those which are disease-producing. We shall recur to those latter for special consideration, but meanwhile we ask you to observe the economic importance of this statement with regard to the common bacteria. What is the evidence of their exclusion? It is the preservation of the milk for weeks without physical change—no souring, no putrefaction. You know what souring means to the producer and purchaser of milk. Yet, what says Lister? "The souring of milk, instead of being—as might naturally be supposed *a priori* from seeing it occur constantly in all milk brought from a dairy—an inherent property of the liquid, is a change which, whether in boiled milk or unboiled, requires the introduction of something from without, and that something a scarce article, both in air and in water, except in dairies. Indeed, even in a dairy, though it exists in all the milk in the pans, it does not necessarily follow that it is the most frequent ferment in the air." This latter fact means that while

* Blyth and Spencer "On the Protection of Milk from Contamination, and the Measures necessary for Maintaining the Purity of Milk supplied to the Metropolis and other Towns."

it is carried and remains inactive in small amount in the air, it flourishes when deposited in the pans. Now, practically, no one wants milk to keep for ever ; but, practically, we also know that it frequently turns sour in a few hours, greatly to everybody's loss and inconvenience. The path to what is attainable in practice is the same as that which leads to the ideal, only not pursued so far, so that I may anticipate the "application" of my sermon by saying that the way to avoid loss from souring and other deteriorations in milk is to remember the conditions of Lister's experiments with his little glasses, and get as near to them as you can—the pure fresh air of the orchard, the clean hands of the dairymaid, the carefully washed teats of the cow, and the pure surfaces of the milk dishes.

Now, let us return to our pathogenic bacteria, those rare members of that constant swarm of bacterial life which is found in milk. In explaining the natural history of the septic, fermentive, and other non-pathogenic or not-disease-producing bacteria, I made use of Lister's experiments ; but I must follow another course with reference to those specific germs of disease. As a rule, they are not so "kenspeckle" as their more harmless congeners. Still, some have been recognised and associated with certain diseases as cause and effect as conclusively as the *bacterium lactis* with "lactic fermentation," or that disease of milk popularly called souring. But there are always these difficulties in the way of exact experiment with pathogenic organisms, that as regards man we cannot perform laboratory experiments upon him ; as regards animals, the argument from analogy is open to question when we seek to apply results obtained on animals to man ; and finally, there are legal restrictions imposed even upon experiments on animals, which throw great practical difficulties in the way of such investigations. But every outbreak of specific disease among the consumers of milk is of the nature of an experiment made upon man ; and, speaking to men not accustomed to the consideration of abstract laboratory experiments it would seem, even apart from the necessities of the case, to be more promising of instruction to take well known cases of disease springing up within the area of a business they understand, and to point out under what circumstances the disease-producing organisms got into the milk. We shall thus, as in the case of Lister's experiments with the *bacterium lactis*, gradually get to a clear conception of what circumstances to avoid, and what to aim at, in the production, collection, and distribution of milk, so as to reduce to a minimum the chances of pathogenic organisms to get access. I shall take the diseases in succession in the distribution of which milk has been proved to act as a medium.

1. *Enteric Fever*.—This was the first human disease traced to milk, so far back as 1857, by Dr. Michael Taylor, of Penrith.

In 1881, Mr. Hart carefully tabulated all recorded instances of milk epidemics.* Up to that date there had been 50 of enteric fever, comprising in round numbers 3,500 cases. Last year the Assistant Professor of Hygiene in the Army Medical School, Netley, continued this tabulation,† and added 19 epidemics, with about 400 cases; so that, in all, 69 epidemics in which enteric fever was conveyed to 3,900 persons by means of milk have been recorded. A number of these have either been investigated by myself, or have occurred within my cognisance in and around Glasgow. I shall run over eight very shortly, noting only the circumstances, so far as could be ascertained, under which the specific germs got into the milk.

1873. This outbreak arose in the service of a dairyman in Glasgow, who sold the milk of his own cows kept behind his dwelling-house. His children had enteric fever, and his wife nursed those children and continued to milk the cows and to conduct the business. The whole structure of the premises tended otherwise to mix up the business with the family life.

1875. In this case enteric fever was planted by a visitor in a village near Glasgow, where it spread through defective sanitary arrangements, and ultimately attacked the child of a dairyman in the village. This child lay in the room from which the milk was sold, and the discharges were thrown into a manure-heap, which soaked not only into the dairyman's well, but into the village well, and then into the water supply of a farm on the outskirts of the village. This farmer's children were soon attacked. The scullery, milk-house, kitchen, and bed-room were all in structural communication. The children lay in a closet off the kitchen. Their discharges were thrown into a manure-heap close to the byre, which had a door opposite the manure-heap. There was no isolation possible, and the persons who nursed the children continued to attend to the business. The result of all these conditions was first a blaze of enteric fever all over the village, and finally a conflagration among the consumers of the farmer's milk in the suburbs of Glasgow.

1875. In the same year an epidemic in Glasgow was traced to a farm in the neighbourhood, where 2 cases of enteric appeared about three weeks before the disease broke out among the consumers of the milk. The boiler-house had three boilers for clothes-washing, scalding milk-vessels, and cooking cows' meat, all built side by side, with a pump close by, the well being beneath the floor. This water was said to be used only for washing dishes. In this wash-house linen soiled by the sick persons was washed on the 10th and 27th August. The first case of fever sickened in Glasgow on the 25th August. There were distinct

* International Medical Congress, 1881: *Transactions*, vol. iv, p. 491.

† "The Connection between Milk Supply and Disease," by A. M. Davies, M.R.C.S. (*Prov. Medical Journal*, July, 1889).

evidences of explosions of the disease corresponding to those washing-days. Another interesting feature of this epidemic was that when the fever broke out the milk agent sent the milk from this farm to another part of the city, but refused to tell me where; and it was not until the fever disclosed the new locality that I ascertained.

1877-8. This was a remarkable epidemic, both in its circumstance and its ultimate results. It involved some of the best residential districts in the West end, including the students of the University, and there can be no doubt was the most active agent in obtaining the Dairies and Milk Shops Order of 1879. Fever attacked the farmer's son a fortnight before the disease appeared in Glasgow. A servant girl and servant lad had also been seized before the infected milk had been traced to its source. The house and all the outhouses were built *en suite*. From the kitchen you passed into the byre at one end; at the other end, just outside another door, and against the wall, stood the privy. Through the boiler-house, with one boiler for scalding tins and washing clothes, you passed to the milk-house. The servant lad lay in the kitchen bed. The son was convalescent. The girl had been sent home. All through, the work of the dairy had been carried on by the persons who attended on the patients. Their discharges were emptied into "the grip," where, among the warm cattle-droppings, the enteric bacteria would find a capital forcing bed or "culture material." This was a very fatal epidemic.

1878. This was a small epidemic in the suburbs, but its circumstances were very instructive. A widow kept 5 cows with the assistance of a daughter. The house, the milk-house, the milk-utensils, the byres, were all scrupulously clean. The water supply was deficient, but good. One boiler-house served for washing and dairy purposes. The milk-house opened right off the kitchen by a door between the window and the fire-place. The daughter had been ill, but she sickened at the same time as the customers. On 24th August a daughter-in-law died in the neighbourhood after a severe illness, the nature of which was not disclosed by the medical man, but the death was certified to be from enteric fever. On the 26th August the widow removed to her little house, her four grandchildren, and a bundle of soiled linen, and washed it there. On the 5th September the fever began among her customers. On the 9th her daughter took ill. On the 11th the last primary case occurred. The epidemic involved 40 persons, and was a distinct explosion following on the introduction of this unsuspected bundle of enteric fever into premises constructed as I have described, and washed in the middle of a milk business.

1880. This was the most extensive epidemic I have seen, involving some 400 persons. The farm had a bad health history. There had been in twenty years, from time to time, several

isolated cases of enteric fever, and a severe outbreak of diphtheria, fatal to two members of the family. The milk-house, washing and boiler-house, kitchen and living apartments, were all *en suite*. The washing-house was only part of the milk-house, separated therefrom by a slim wooden partition, the one boiler for all purposes standing in a recess in open communication with both places. The water-supply was from a well in the yard, the water of which was found to be contaminated, and from a dip well at the bottom of a slope below the manure-heap. The pump was "out of fang," and I saw the farmer pour in some dirty-looking water to set it going! A dairymaid fell ill on 12th March; two children sickened on 25th March. On 26th March the first consignment of 11 gallons of milk was sent to Glasgow. On 9th April the fever broke out among the customers of the unfortunate agent who received it. The sick children lay in a room opening off the kitchen. The dairymaid passed through her illness in a garret above the milk-house and washing-house; and the stains upon the floor beneath the bed, visible to my eyes two months after, bore evidence to the severity of her case, to the carelessness of the people, and the attendant risks of such a position for a sick bed. The discharges were thrown over the dung-heap. The dairymaid's mother nursed her, and she washed overnight at the dip-well the soiled changes of bed and body-linen. I leave you to imagine for yourself under what conditions during those spring months the milk at this farm must have been first milked and then set out to cream in that milk-house. It was only sent into Glasgow every third or fourth day, and must have been by the time it reached the consumer a veritable essence of fever. That it really was such the extent and virulence of the epidemic experimentally demonstrated. The agent who received it admitted to me that it was not "guid keeping milk." How could it be? It is just farms which are reputed to produce "ill keeping milk" that may be expected some day to send in milk which not only swarms with the *bacterium lactis*, but has also acquired one or other of the rarer pathogenic bacteria.

In 1881 a small epidemic arose from a little farm kept by the farmer, his mother and sister. The house consisted of "a but and a ben," separated by a passage which was used as a scullery and washing-house from the milk-house and byre, the whole being *en suite*. The door of the milk-house was near the boiler. The farmer sickened of enteric fever, and was nursed in the room off the kitchen by the mother. There was no convenience on the steading. The discharges were thrown on the manure-heap and on the surface of a contiguous field. The well was at the back door of the passage, and was fed by surface drains. The soiled linen was washed in the passage.

In 1884 over 100 patients and officials in certain hospitals in Glasgow were attacked with enteric fever. All the institutions

involved were supplied by one milk agent, into whose hands came the milk from a farm at which a dairymaid fell ill of the same disease on the same day as the first case sickened in Glasgow. She, therefore, cannot have been the cause. The farm well was found on analysis to be "grossly contaminated with the products of sewage." The epidemic broke out in August, when the cattle were out at pasture. The only water they had to drink was from two burns which traversed those fields, and which received the sewage of two mining villages in which enteric fever was a chronic disease.

These cases afford illustrations of nearly all the special circumstances surrounding the occurrence of the specific germ of enteric fever in milk. In the numerous milk epidemics recorded in other places we find such incidents as these—people milking the cows who were nursing the sick; milk-cans washed with the same dish-cloth which was used about the persons of the sick; milk-cans exposed in the same room with the sick; soiled linen lying about among the milk-dishes.

2. *Scarlet Fever*.—Fifteen epidemics of scarlet fever, originating in the distribution of infected milk, and involving 800 persons, were collected by Mr. Hart in 1881, and eighteen which occurred since that date by Professor Davies, involving over 800 persons. There are two features of this disease which make it a specially dangerous one when it exists in the families of persons engaged in the collection and distribution of milk. One is, that during convalescence the scarlet fever patient desquamates or casts the skin, and that it is in this skin the special microbe of scarlet fever most abounds. The other is, that attacks of scarlet fever are frequently so mild as to escape serious notice. There may be only a transient sore throat, either with or, so far as observed, without any eruption. There may be only the faintest blush on the chest. Yet, even in such undetected mild cases, there is a modified casting of the skin, not, it may be, in flakes, but as a fine dust. Wherever scarlet fever exists, therefore, the air is charged with infectious dust, which settles down on exposed articles and surfaces, whether it be the clothing of those attending or only entering the same apartment as the sick, or the milk vessels in the neighbourhood, or the milk exposed in them to allow cream to rise. The chief victims of this disease are, of course, children, so that the existence of a family of young children, especially where the dwelling-house, the milk-house, and the scullery are in structural connection, implies a constant threatening of possible mischief to the farmer or the milk agent. After the febrile stage is past, even in well-marked cases where the true nature of the illness is obvious, the child speedily regains all its natural vigour. During the six weeks or more of subsequent desquamation, it is difficult to restrain children. They ought, for their own sake, to

be confined to bed, or at least to one room. Instead of this, it is quite common to find them scampering about all over the premises, creating, wherever they go, an infected atmosphere. In towns the usual agents for the distribution of milk to customers are children; and the first step I take, when a suspicion arises of scarlet fever among the customers of a milk agent in Glasgow, is to get a list of those juvenile distributors, and have them all carefully examined. A general survey of recorded epidemics of scarlet fever from infected milk shows that the great majority are at once explained by these properties of the disease. Either the family of the farmer has had scarlet fever, or the family of some milker—it may be a man or a woman—who lives in a small house, nurses the children, and sleeps in the same apartment, possibly in the same bed. Sometimes a milker has had in his or her own person an unobserved attack, and is found to have been milking while the process of desquamation was progressing, impregnating every drop of the milk with the germs, which at once begin to grow and multiply in this warm and nutritious “culture material.” Hence the circumstances of these outbreaks do not usually lead us to the discovery of impure water, bad drains, and those gross and obvious insanitary conditions which surround epidemics of enteric fever at their source. They generally direct our attention to the constant risk attending upon the structural connection of the house and the family life with the milk-house, the byre, and the premises which ought to be cut off for the purposes of the dairy business. In all cases, but especially where there are children about the farm, or where persons employed as milkers or otherwise about the dairy come from neighbouring villages, or live in family as cottars, the risks of accidental contamination arising are intensified by this connection. All the greater, therefore, is the necessity of constant and suspicious circumspection as to the health, not only of the actual workers, but of their families.

While the great majority of milk epidemics of scarlet fever may be satisfactorily explained by such circumstances as those, which all end in one way or another in the introduction from a diseased human being into the previously pure milk of the pathogenic germ of scarlet fever, there have been undoubted milk epidemics of which the most careful scrutiny of the facts furnished no such explanation.

In recent years, competent medical men, trained in the investigation of epidemic outbreaks, practised in the use of modern methods of research, accomplished bacteriologists and microscopists, have become convinced that certain obscure diseased conditions in the cow may originate scarlet fever in man. My own opinion is that the evidence adduced proves conclusively that milk may acquire the power to impart scarlet fever independently of the intervention of a human source; and that this

disease-producing power has been found to disappear from the milk of a dairy which undoubtedly had the property of conveying scarlet fever to its consumers, when the milk of certain cows was excluded, and to appear in the milk of a dairy previously innocuous, when the milk of those cows had been included and distributed therewith. If these are facts, and in my humble opinion they are, then we cannot escape the conclusion, if we are to reason from facts at all, that the cow is the subject of some rare diseased condition which arises from or results in the existence of the specific germ of scarlet fever in her body, and consequently in the milk which she secretes. The question is, What is that diseased condition; what are its characteristics in the cow; how are we to recognise it; or can we come so close to the identification as to be able to say it is one or other of several conditions, however trifling and superficial as regards the cow we may hitherto have held them to be? I am not going into the detailed discussion of these questions at this time. It would lead me into a controversy which has a voluminous literature, in which the highest authorities in the land are at present engaged, which will, no doubt, be settled by the discovery of the truth some day soon, but which is at present far from such an issue. You will find an excellent short summary of the arguments on both sides in that paper by Professor Davies, to which I have frequently referred. Suspicion rests upon certain eruptive diseases of the teats and udders of cows. I show you some admirable coloured drawings of those eruptions in a report by Professor Brown, of the Agricultural Department of the Privy Council Office. I may also state that I investigated, in conjunction with Professor M'Call and Dr. Carmichael, both of this city, an epidemic in which cows affected with eruptive disease of the teats, with loss of hair and casting of the skin, showing a constitutional affection, were found in the byre which contributed milk to the supply of the infected consumers. Those cows were purchased by the Local Authority of Glasgow, and placed for observation in Professor M'Call's premises. He fed a calf with the milk of those cows, and the animal was seized with a severe febrile illness, resulting in copious desquamation, which, in short, was in the opinion of all who observed the case, both veterinary and medical, scarlet fever in the calf. Further, curdled masses, which at times plugged the teats, were found to swarm with bacteria. Milk drawn by a sterilised tube was found to contain the same bacterium, so that it came from the cow with the milk, and was not added from the air. Finally, the blood of the calf contained this bacterium, and this only.

Now, gentlemen, I am a practical man, although not regarded as such in all circles. I am constantly required, in virtue of my office, to take a general survey of theories of disease, and new principles which have relation to the daily work of practical

sanitation, and to endeavour to draw some conclusion which may be put to immediate use for the guidance of myself and others. In the present case my practical conclusion is this, that milk produced by a cow which is not absolutely healthy, both constitutionally and locally, should not be used as human food. I care not what may be the deviation from the normal, whether it be a high temperature or some condition of the skin usually ascribed to change of food ; some casting, not merely of the hair, but of adherent flakes of cuticle ; or merely a chapped teat which bleeds in the milker's hands ; or some outbreak of vesicles or pustules, the contents of which get mixed with the milk, and the abrasion of which morning and evening produces scabs and sores—in all cases of recognisable disease, local or general, I advise you to sacrifice the milk of that cow rather than run unknown risks of contaminating the whole produce of your dairy. The most painful experience of my official life is to see the financial loss, the remorse, arising from the conviction that disease and death have been caused through some action or default of theirs, inflicted upon farmers and milk agents by these epidemics. The Scotch farmer is a thoughtful, conscientious man, naturally somewhat incredulous about the warnings of science ; but he is as anxious as any one can be to do what in him lies to avoid such disastrous experiences, and this is my advice to him. I am happy to state that Professor Brown, who is sceptical about the doctrine of cow scarlet fever, thoroughly coincides with me in his opinion as to the practical lessons to be deduced from it. Whether the doctrine be established or demolished, the practice of the dairy farmer should be the same. It is so important to convince you that I, as a medical expert, and he, as one of the foremost veterinary authorities in the land, stand shoulder to shoulder in this all-important matter, that I conclude this part of my paper by quoting his own words from the report referred to :—

“Milk is often collected, both in country and town, with contemptuous disregard of the most elementary sanitary precautions, amidst surroundings which can only be characterised as filthy. Dirty premises, diseased and dirty udders and teats, to say nothing of the state of milkers' hands, are stern realities which can be seen by any one who is curious in such matters ; and they must inevitably lead to contamination of milk with septic bacteria, and often with infective matter, not only from consumptive cows, but also from the attendants, who are subject to little or no supervision.

“It is true that in some model dairies a contrast to the above description is exhibited, where absolute and scrupulous cleanliness is insisted on. The health of the attendants is strictly watched, and any temptation to conceal a trifling ailment is counteracted by the arrangement which allows the milkers full pay during absence from illness. The slightest sign of udder disease, or

other disease, in any of the cows is accepted, as it certainly should be, as a sufficient reason for excluding the animal's milk from the common stock. Under such conditions, milk may be collected as free as possible from specific or common micro-organisms. This degree of care has not yet been generally taken, nor will be until the authorities interpose and insist that the cleanliness and perfect sanitary arrangements which are now exhibited in a few dairy establishments must be the only conditions under which the trade of a dairyman can be permitted to continue."

I ask you to note every word of this sentence—"The slightest sign of udder disease, *or other disease*, in any of the cows is accepted, as it certainly should be, as a sufficient reason for excluding the animal's milk from the common stock."

3. There are fourteen epidemics of *Diphtheria* caused by milk on record. I have not seen any myself, but am not surprised at their occurrence, as diphtheria is more prevalent in the country than in towns. Nor am I surprised at the mystery which surrounds their circumstances, because in all its movements everywhere diphtheria is a mysterious disease, difficult to track to its lair. In only one of the fourteen epidemics was disease found in human beings at the dairy, prior to the outbreak among the customers; in another, it attacked the customers and the dairy hands simultaneously. In five instances very gross insanitary conditions were found at the farm, and in close relation with the milk:—(1) Well very much polluted, open drains in yard, and untrapped gully inside the dairy; (2) pipe from sink where milk tins were washed untrapped; (3) milk cans very dirty and kept in scullery, where waste-pipe to sink was untrapped; dirty linen lying about among the cans; (4) dairy utensils washed in a brook contaminated with sewage; the milk had been observed to be ropy; (5) polluted well at dairy. I am much impressed with the references to untrapped or otherwise open drains in such a position as to discharge their effluvia over the milk vessels or the milk. This is just the sort of thing I observe associated with diphtheria in the city, and the conditions suggest that the specific bacterium got into the milk, and there developed in such abundance as to infect its consumers; although, in the free ventilation of the country, it did not reach the residents at the farm in infective strength, as it more readily does in the confined and stagnant air of town houses. In half of these outbreaks no explanation whatever seems to have been even suggested by the surrounding circumstances; and in two a peculiar inflammation of the cow's udder, called "garget," was observed, and the surmise was thrown out that this might be the cause. I cannot say it is more than a surmise, and I refer to it because this lends additional support to my contention that, in the present state of our knowledge, no diseased condition whatever of a cow in milk

ought to be overlooked as of no importance as regards the interests of the consumer.*

4. We come now to *Tuberculosis*. This is a disease common to man and the lower animals, and in both caused by the *bacillus tuberculosis*, an organism which is comparatively readily recognised. It is well known that tuberculosis is very common among dairy cows, especially such as are kept stalled in confined and badly ventilated byres. It has long been known that the bacillus might be present in the milk of tuberculous cows, and that such milk might impart the disease to the consumer. Until a few months ago, however, the generally received opinion was that only when the udder was locally diseased could the bacillus enter its secretion. This has now been proved not to be the case, and I specially wish you to observe from what quarter this proof has come. "The Massachusetts Society for the Promotion of Agriculture" promulgated the question, "How far may a cow be tuberculous before her milk becomes dangerous as an article of food?" commissioned an expert, Dr. Ernst, of Boston, to enter on an experimental investigation for the solution of the question, and supplied the funds and conveniences. The investigation is not yet completed, but its first fruits were submitted to the Association of American Physicians at their meeting in Washington last September. The paper is published in the *International Journal of the Medical Sciences* for November, 1889. Dr. Ernst tells us that the Massachusetts Society had given him "everything in the way of pecuniary and moral support that the work has required; my own part has been that of general director, and I have had associated with me during the whole time the Society's veterinarian, Austin Peters, D.V.S. For the last year I have had the very valuable aid of Dr. Henry Jackson and Langdon Frothingham, M.D.V. All of the inoculation experiments, and most of the microscopic work, have been done in the bacteriological laboratory

* On 22nd May last a paper was read before the Royal Society of London—"A Contribution to the Etiology of Diphtheria"—by Professor Klein, F.R.S., which warrants a positive opinion as to the possibility of diphtheria being implanted in the system of the cow and transmitted through the milk to man. The observations on the cow branched out from an investigation into the relation between a form of pulmonary disease in cats, which had been noted as occasionally coinciding with diphtheria in man in the same house. It was proved that the same organism is found in both diseases. Two healthy milch cows were inoculated with a culture of the bacillus of human diphtheria. A serious illness, fatal to one, ensued in both, consisting in lung and kidney disease, during which *an eruption appeared in successive crops on the teats and udder*. The bacillus was abundant in the milk, drawn with precautions against contamination, and also in matter from the eruption. Cats which partook of this milk died of the specific pulmonary disease; and calves inoculated with matter from the eruption developed a like eruption, and had a specific lung and kidney disease. [Added 18th June, 1890.]

of the Harvard Medical School, some of the microscopic work at the Society's laboratory in Boston, whilst the feeding experiments have been done, and the experimental animals kept at a farm in the country devoted to this especial purpose, and situated among the healthiest possible surroundings. Nothing has been set down as the result of microscopic observation that I have not myself verified, and every portion of the work has been carried out under the most exacting conditions, and with every possible precaution against contamination." I set forth the origin and circumstances of this investigation with this fulness, not only to give you confidence in its first results, but also to do honour to the intelligence of this Society of American agriculturists, who thus recognised science as their best friend. Dr. Ernst states the preliminary conclusions of this Commission in four short propositions:—"1st, and emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease. 2nd, That the virus is present whether there is disease of the udder or not. 3rd, That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis. 4th, That, on the contrary, the bacilli of tuberculosis are present and active, in a very large proportion of cases, in the milk of cows affected with tuberculosis, but with no discoverable lesion of the udder."

In view of these grave facts, I can only express the hope that this American Agricultural Commission will be able to put us on the way of diagnosing tuberculosis in cattle in its earliest stages. That seems in the present state of veterinary knowledge to be the great practical desideratum. I am hopeful that now when the importance of this disease, both in respect of agricultural economics and of public health, is established, some of the refinements of observation which have long been successfully applied by physicians to the detection of tubercle in its beginnings in man may be found to be equally applicable by veterinarians to its prompt discovery in cattle. Meanwhile, there can be no doubt that the *prevention* of tubercle in cattle should engage the attention of farmers and breeders of stock. They can control the propagation of the disease by inheritance in ways which are not open to man in reference to his own species. Physicians protest against "foolish marriages" of human beings in vain, but the stock breeder has that in his own hands. Above all, farmers must learn that the conditions which promote the health of the cow are essentially the same as those which promote the health of man. The bacillus of tubercle, like all those pathogenic germs, seeks out the debilitated and unhealthy. It flourishes in creatures, whatever their grade in the scale of organisation, living in unwholesome conditions, especially those which consist in foul air, want of light and ventilation, general uncleanness, insufficient food, over lactation. Professor Brown says in his Report on Eruptive Diseases in

Cows :—" Nothing worse than the insanitary conditions of life of the average dairy cow can be imagined." So long as this is true, and wherever it is true, you will have tuberculosis, with all its financial losses in the shape of condemned meat and milk which is dangerous for the public to consume. It is a money question for you, and a health question, which is ultimately also a money question for the public. For both there is but one solution—give your cows sufficient space, and ventilate it so as to secure fresh air in the byres, feed and milk them judiciously, reduce the conditions which befoul the air by scrupulous cleanliness of all the surfaces of the byre and the coat of the cow herself. Then you will not only reduce the risk of tuberculosis, but you will sweeten the conditions under which your milk is produced and collected. It will improve in quality, and keep better.

5. There is one other disease of the cow which has been observed in the consumers of her milk—*Foot-and-mouth disease*. In man the local manifestations generally are limited to the region of the mouth and throat, though congestions of the palms and soles have been observed. I may also mention a disease common to man and the bovine species, which is coming daily into greater prominence—*Actinomycosis* of the ox and man. It resembles tuberculosis in being the result of a distinct organism, but much larger and conspicuous. It is called the "rayfungus" from its shape. The diseases have many points of similarity in their general symptoms and *post-mortem* appearances. Indeed, there can be little doubt that this new disease is being redeemed by advancing skill in microscopic and pathological research from the domain of tuberculosis. It occupies the greater part of the last annual report of the Agricultural Department of the Privy Council Office. I merely introduce you to this new terror. I am not sure that you will hope to make his better acquaintance on a future occasion.

Food is, of course, what may be called the basis of the normal milk, and may therefore be the cause of abnormal conditions prejudicial to the consumer. There is a disease which frequently affects cattle in Western America, known as "trembles," which arises from eating the leaves of the *Rhus toxicodendron*, or poison-oak. The milk produces poisoning, sometimes with fatal results to children. Many other illustrations of the passage of noxious effects from herbs and plants through the cow to man might be quoted.

In France, where bottle-feeding of children is so common, a sudden great increase in the mortality from diarrhœa, and other diseases showing irritation of the stomach and bowels, was observed to follow the establishment of a large distillery in a certain district. The cause was found to be the use of "brewers' grains" in feeding the cows of the neighbourhood, and the acid

and irritant quality of the milk produced. Brewers' grains are injurious when kept until they sour or ferment, and when they form an excessive proportion of the cow's entire food. I observe, however, that the opinion of American farmers is "that the milking life of the cow is shortened by the use of this food, and that its use should be discountenanced." * *Swill milk* is a term well known in America, designating milk produced by cows fed on *distillery swill*. It is a weak, watery, not only unnutritious, but unwholesome fluid, very injurious, and even fatal to children. The sale of such milk is forbidden under penalty of fine and imprisonment in most of the States.

Mr. Smee, a well-known chemist and dairy farmer, tells us, as the result of experiments, the details of which he gives, "the milk derived from a cow fed on *sewage grass* went putrid and stank after thirty-six hours. The butter from sewage-grass fed milk became rapidly rancid, compared with milk from cows fed on ordinary meadow grass." † The comparative analyses given of sewage and ordinary grass make the cause of this difference quite clear.

The necessity of judgment in feeding milch cows is well shown by another observation of Mr. Smee's. "In one case such large quantities of oil-cake were given that the milk became perfectly useless for the table; large quantities of a rancid oil floated on the surface after boiling this milk." All observers are agreed as to the deleterious effects of *impure water* upon milk and its products. We have seen that it may cause active disease in the cow and give a specific infecting power to her milk; but short of these effects, the daily produce of animals who drink impure water is deteriorated; it keeps badly, and the butter is of low quality.

It is scarcely necessary to add a word of warning on the impropriety of using milk from *a cow under medicine*. Apart from the diseased state which necessitates the medicine, it is well known that all soluble salts may appear in the lacteal secretion. Physicians constantly treat diseases in the sucking child by administering the medicine to the mother. Saline purgatives give a laxative property to the milk.

After we have got the milk, if we choose to expose it to unwholesome surroundings, we are not to imagine that so long as we avoid glaring milk epidemics we may do no harm. Like all organic bodies, milk, by simple decomposition, acquires poisonous properties from the formation of animal alkaloids, the result of the vital processes of the septic bacteria, which are behind all decomposition. Many diarrhœas, and simultaneous attacks in families of vomiting, giddiness, purging, and depression, originate in this way. Mr. Smee proved this by experiment. He exposed

* *Report of Board of Health, State of New Jersey*, 1880, p. 229.

† *Milk in Health and Disease*, by A. Hutchison Smee, M.R.C.S., F.C.S., 1875.

milk in open vessels to sewer gas from an untrapped drain, and obtained from it "a distillate which had an offensive smell and unpleasant taste. Tasting the distillate set up an intense headache, vigorous, rapid pulse, and was followed by severe diarrhœa." In fact, he found that the distillates of milk exposed to decomposing animal matter were so offensive and dangerous to health that he did not continue his experiments. As compared with pure milk, this tainted milk went bad much more rapidly. But it is one of the commonplaces of intelligent dairy management that milk is a "kittle" article. It is susceptible, through the cow, to all the conditions of her environment and management; and it is no less susceptible, after it has been collected from the cow, to every kind and description of abnormal influence.

Now, gentlemen, I have done. The plan of my lecture has been to produce a thesis in support of my little pamphlet "On the Sanitary Requirements of a Dairy Farm,"* which was recently distributed by the Local Authority of Glasgow among the farmers who were supplying milk to Glasgow, numbering over a thousand. Any one interested in the milk trade may get a copy either from the Secretary to your Society or at the Sanitary office. I have explained to you the facts and scientific theories which were present to my mind when I wrote this pamphlet. I have only now to ask you not to allow yourselves to wander into discussions and questionings as to the validity of the cases of infection conveyed by milk which I have quoted; but rather to ask yourselves whether, apart from any theory as to their consequences you can approve of the conditions discovered, described, and denounced under the guidance of the theory. Is it right that farms should have a bad water supply or bad drainage; that farm-steadings should be so constructed that milk-houses are exposed to contamination; that they should have no conveniences, or conveniences which are offensive to decency; that clothes should be washed where milk-vessels are scalded and kept; that women should go from the bedside of the sick to milk cows; that those disgusting intermixtures of milk, milk-vessels, and soiled linen should continue? Of course, if these facts did not, in my opinion, endanger the health and life of the consumers of milk, I should not concern myself about them; but whether I am right or wrong in this belief, the facts remain, and I confidently assert that you cannot defend them, that you are bound to remove all those insanitary conditions, to prevent those objectionable practices. If you do, first of all your own health will be improved; and next, when disease invades your household, you will no longer suffer loss or be the cause of loss to others either in health, life, or money.

* Reprinted in the *Sanitary Journal* for April, 1889.